Instrument Incubator

Cold Atom Gravity Gradiometer for Geodesy

Completed Technology Project (2014 - 2017)

Project Introduction

We propose to design, build and test a high-performance, single-tensor-component gravity gradiometer applicable to Earth science studies on a satellite platform in low-Earth orbit. The instrument will take advantage of the long interrogation times that are available in microgravity environments. Our proposed design is based on light-pulse atom interferometry using cold atoms, and implements recent developments in atom cooling, interferometry and detection technologies. The sensor incorporates an intrinsic method of compensation for rotation-induced errors in the gravity gradient measurement. The gradiometer has a target gravity gradient noise floor of 7Ã—10 5 E/Hz1/2 when extrapolated to operation in a low-noise microgravity environment. This is an improvement over the noise performance of ESA's Gravity field and steady-state Ocean Circulation Explorer (GOCE) gradiometers, whose short-term noise is approximately 3Ã—10 3 E/Hz1/2. In contrast to NASA's Gravity Recovery and Climate Experiment (GRACE) mission, the instrument will be capable of high-precision geodesy from a single satellite platform. In contrast to previous gradiometers based on atom interferometry, the proposed instrument achieves orders-of-magnitude improvements in sensitivity by exploiting the advantages of the microgravity environment. At the outset of the program, we will perform analysis and trade studies to determine sensor design parameters. At the same time, we will begin to conduct technology validation studies to reduce technical risk and select instrument components. We will create conceptual and detailed designs of the sensor that will lead directly into the sensor build effort. Following completed assembly of the instrument, we will conduct laboratory optimization and testing. The culmination of the program will be testing at the long interrogation times that will be achievable in a microgravity environment. The proposed performance period is three years. The initial TRL will be 3, and through testing in the laboratory and in a simulated microgravity environment we will advance the TRL to 5.

Anticipated Benefits

GRACE-II relevant but not specific

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Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Center / Facility:

NASA Headquarters (HQ)

Responsible Program:

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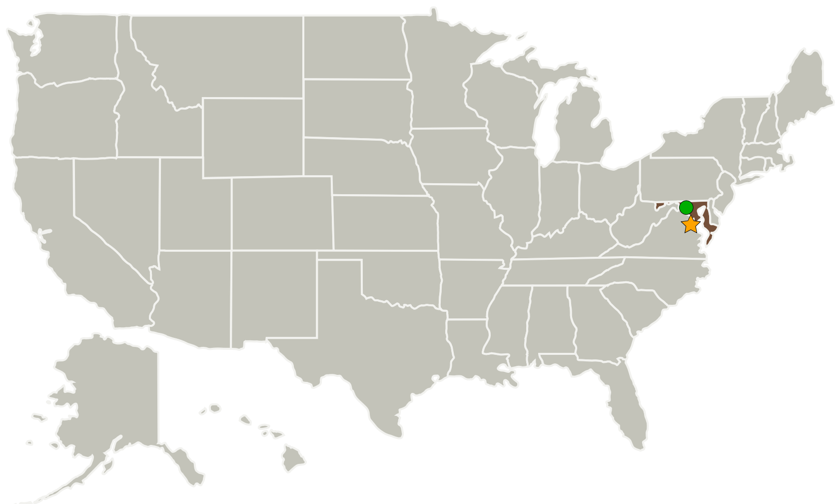
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★NASA Headquarters(HQ)	Lead Organization	NASA Center	Washington, District of Columbia
●Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations
Maryland

Project Management

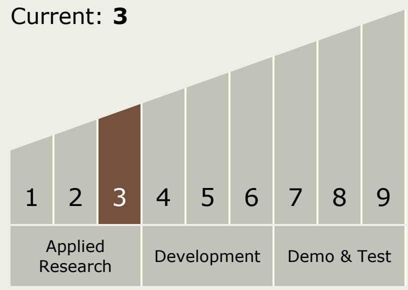
Program Director:
Pamela S Millar

Program Manager:
Parminder S Ghuman

Principal Investigator:
Babak N Saif

Technology Maturity (TRL)

Start: **3**
Current: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.5 Lasers

Target Destination

Earth